Comment on the Federal Communications Commission's *Mitigation of Orbital Debris in the New Space Age*, 84 FR 4742 (proposed February 19, 2019)

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Executive Summary

The Federal Communications Commission (FCC) released a notice of proposed rulemaking and order on reconsideration regarding the Mitigation of Orbital Debris in the New Space Age[2] (hereby, "NPR") on February 19, 2018. Citing the United States' preponderance of investment, advancement, and deployment of space commerce technologies, the FCC set out in this NPR a discussion of a new rule regarding the future management of space operations to mitigate the exponentially increasing risks of orbital space debris collisions. This Comment responds to the FCC's request for comment in connection with this NPR. We comment to suggest that the FCC consider opportunities to further involve other vested stakeholders and incentive structures to further strengthen its ability to mitigate the risks orbital debris pose to telecommunications, space commerce, as well as to the health and safety of human life.

Specifically, this Comment provides four analyses of the topics requested for comment by the FCC's NPR and makes four recommendations including the FCC's collaboration with stakeholder agencies across the Executive Branch and internationally, to consult with these stakeholders to convene international standards for space technologies, and to implement an incentive structure mirroring the Food and Drug Administration's Priority Review Voucher

[1] The authors are all participants the Duke Science Regulation Lab, an interdisciplinary program offered through the Duke University Law and Graduate Schools.
[2] Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742 (proposed Feb. 19, 2019)

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program. In support of this position, this Comment 1) identifies the opportunities and limitations of the FCC's ability to mitigate orbital space debris; 2) identifies the varied and valuable input of other stakeholders in space commerce and related technologies and 3) provides an analysis of the ways in which the jurisdiction of the Earth's orbit may be defined and what incentive models would be most conducive to stakeholders and the mitigation of orbital space debris.

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I. Introduction

A. Who We Are

The Duke Science Regulation Lab (SciReg Lab)[3] is composed of graduate students from a variety of disciplines at Duke University, including science, law, ethics, and policy. The SciReg Lab was originally inspired by the traditional role of *amicus curiae*: to provide a court with unbiased information necessary to reach a binding decision. As an extension of that concept, we now provide government agencies with the scientific information necessary to undertake effective rulemaking.

Modern society requires our government to handle increasingly complex scientific issues when deciding cases or making policy. We, the Duke Science Regulation Lab, believe that the general public benefits from judgments that are based on sound scientific knowledge. To assist decision makers in understanding a scientific matter at hand, the students of the Science Regulation Lab combine their expertise to offer a non-partisan, accurate, and accessible explanatory brief or comment.

The members of the Duke Science Regulation Lab vary in their academic backgrounds. **E. Scott Brummel** is a researcher with Duke University Robotics and is Lead Editor for Robotics and AI policy coverage at SciPol.org, **Ashle Page** is an MA candidate in Bioethics and Science Policy, and **Cole Wilhelmi** is a JD candidate who is jointly pursuing an MA in Bioethics and Science Policy.

[3] Michael B. Waitzkin, JD, J. H. Pate Skene, JD, PhD, and Sarah Rispin Sedlak, JD, are the faculty members who lead the SciReg Lab and who oversaw the preparation of this Comment. We would also like to thank Charity Weeden, President and Co-Founder of Liquinox Consulting, LLC, an independent space and data management consulting company, for providing valuable insight, analysis, and editing assistance throughout the preparation of this comment.

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B. The Federal Communication Commission's Request for Comments

This comment responds to the Federal Communications Commission's (FCC) request for comments and supporting data related to "the suitability of various orbital debris mitigation guidance and standards for application to non-Federal satellite systems."[4] The FCC specifically asks for public input on four primary different modifications to 46 CFR 5, 25, and 97, including to:

> (1) Require satellite applicants to demonstrate compliance with certain metrics developed for assessing orbital debris mitigation plans by the National Aeronautics and Space Administration (NASA)[;]
> (2) Require additional disclosures to the Commission regarding risk of collision, trackability, maneuverability, proximity operations, if any, choice of orbit, and impact on manned spacecraft, if any[;]
> (3) Require information regarding the probability of success for the chosen disposal method, where disposal is planned by atmospheric re-entry[; and]
> (4) Require satellite applicants with planned operations in certain orbits to make certifications related [to] deploying at a lower orbit and then raising the satellite(s) for operations.[5]

The Commission additionally "seeks comment on whether there are any areas in which proposed requirements may overlap with requirements that are clearly within the authority of other agencies, so that we may seek to avoid duplicative activities."[6]

In responding to this request for comments, we recommend that the FCC work with national and international partners to address the issue of orbital debris from multiple perspectives as this issue affects a multitude of sectors. If no action is taken to institute clean-up methods of orbital debris, develop design and operational protocols for

[4] Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742 (proposed Feb. 19, 2019).
[5] *Id.*
[6] *Id.*

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operators, and work with international partners, a number of key assets within the United States economy and security will likely suffer. In particular, orbital debris and its continued presence in outer space will have negative impacts upon national competitiveness, defense, space operations, commercialization of space, research, and education.

Within this comment, we demonstrate the scope of the problem with the current state of orbital debris by addressing that the uncertainty of risk in this area could have a significant stifling effect upon United States commercial and government operations in space. Based upon these challenges, we recommend the following short-term actions:

1. **The FCC should work with other federal agencies to develop an inter-agency task force to collectively provide perspectives necessary to establishing uniform national standards and prospective plans for the future of orbital debris.** At the very least, this task force should include members of the FCC, the National Aeronautics and Space Administration (NASA), the Department of Defense (DoD), the Department of Commerce, the National Geospatial-Intelligence Agency, the National Reconnaissance Office, the White House Office of Science and Technology Policy, and the Small Business Administration. These discussions should also include the input of non-government entities such as companies with current satellites in space to gather more information necessary to establishing a coordinated effort to aid in space traffic management.

2. **The FCC should utilize the information gained through an inter-agency task force to incorporate the concerns of space actors internationally.** The FCC should raise its concerns within a forum before the United Nations Office for Outer Space Affairs to begin establishing a process for space traffic management similar to that of international air traffic control. Without international cooperation, any independent national attempts to enact clean-up policies in space will prove null without coordinated efforts to regulate space objects themselves and to manage space traffic.

3. **The FCC should work with other agencies to institute a set of standards for future launched objects, requiring them to meet certain criteria.** These criteria should include: maneuverability to enable satellites to avoid collisions with debris, a self-contained mechanism built into the satellite's

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design to dispose of itself, and a tracking capabilities to aid with space traffic management.

4. **The FCC should develop incentives to counterbalance any adverse effects of introducing new regulation of launched space objects.** Potential tax, research, or education-based incentives could ensure that satellite operators remain compliant and that innovation is not halted because of regulation. In addition to maintaining current research within launching satellites, these policies should incentivize companies to develop innovations to tackle space debris challenges.

Each of these recommendations is dependent upon taking small steps to address the complexity of the current environment of space. Implementing these recommended actions can ultimately aid in protecting current and future satellites from interference with space debris.

II. The Technical Challenges of the Current Landscape in Outer Space: Current Operations in Space and the Dangers of Orbital Debris

It is estimated that there are currently tens of thousands of artificial objects in space. In 2016, the United States Space Surveillance Network catalogued total of 17,729 of these objects above the Earth.[7] The objects range in size from only a few millimeters to meters in diameter. The European Space Agency (ESA) reported in January 2019 that more than 128 million pieces of debris smaller than 1 centimeter were estimated to be in Earth's orbit.[8] An estimated 900,000 objects between 1 cm and 10 cm in size were also reported in addition to approximately 34,000 objects greater than 10 cm are estimated to be in orbit.[9] According to NASA, the debris travels at

[7] *Orbital Debris Quarterly News*, NASA (July 2016), https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv20i3.pdf.
[8] *Space Debris by the Numbers*, EUROPEAN SPACE AGENCY, https://www.esa.int/Our_Activities/Operations/Space_Safety_Security/Space_Debris/Space_debris_by_the_numbers.
[9] *Id.*

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speeds up to 17,500 mph.[10] As a result, even small objects or debris can have damaging impacts upon operational communication, defense, and research satellites in space. Because the force exerted by a colliding object is affected by not only the object's mass but also its acceleration, even very small pieces of orbital debris colliding with a communications satellite could have a severe impact. For example, even on Earth, small rocks traveling at high speeds and hitting an oncoming car at a high speed can cause severe damage to the car's windshield. These dangers are even more amplified for satellites orbiting in space. This is particularly concerning to companies both in and outside of the United States. With increasing numbers of launches, the risk of losing valuable satellites and the negative impact upon the space sector may ultimately prove restrictive upon future attempts at national competitiveness and economic development in space.

Up until India's recent planned anti-satellite test, the International Space Station (ISS), was relatively clear of the dangers of space debris.[11] In April 2019, NASA Administrator Jim Bridenstine criticized the event, remarking that "that kind of activity is not compatible with the future of human spaceflight we need to see have happen."[12] Even small pieces of debris traveling at high speeds can cause considerable damage to other satellites. Adding to this danger, these small objects often cannot be tracked.[13] Because of the lack of ability to track these objects,

[10] Mark Garcia, ed., *Space Debris and Human Spacecraft*, NASA (Sept. 26, 2013), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.
[11] Kai Schultz, *NASA Says Debris From India's Antisatellite Test Puts Space Station at Risk*, NY TIMES (Apr. 2, 2019), https://www.nytimes.com/2019/04/02/world/asia/nasa-india-space-debris.html.
[12] Brett Molina, *India's missile test sent dangerous space trash hurling near ISS: NASA chief*, USA TODAY (Apr. 2, 2019, 1:57 PM), https://www.usatoday.com/story/news/nation/2019/04/02/nasas-jim-bridenstine-india-missile-test-poses-greater-risk-iss/3339958002/.
[13] Sandra May, ed., *What Is Orbital Debris?*, NASA (June 8, 2010), https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-orbital-debris-58.html.

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satellite developers must either attempt to build operational space infrastructure to withstand any damage caused by high-speed collisions with debris, or design satellites to include systems to recognize the harm beforehand and to move the structure out of the object's expected path. These operators must ultimately bear the design and production costs of designing their satellites to either avoid risk through tracking or resist damage by way of innovative materials design. Currently, however, the ISS can only slightly change its trajectory to avoid space debris.[14] This debris can have large consequences upon the operations of satellites. For instance, in 2007, China's use of a missile to destroy a defunct satellite, and in 2009, the collision of a United States communications satellite and a defunct Russian satellite, have been estimated to have caused more than a third of all recorded debris currently in space.[15]

Attempts to implement spaced debris removal mechanisms are currently limited to launching a "clean-up" satellite with a ferromagnetic arm to attract pieces of debris in orbit.[16] All pieces of space debris, however, are not magnetic. Other attempts to remove debris include a February 2019 "harpoon" research test with the University of Surrey's "RemoveDebris" mission.[17] The United States Defense Intelligence Agency also commented in February 2019 that China is working on developing a sophisticated space debris clean-up system.[18] Other current technology includes radar-reflectors placed on satellites to identify approaching orbital debris to

[14] *Id.*
[15] Anthony Capaccio, *China's Space Debris Cleanup May Be Cover Story, Pentagon Says*, BLOOMBERG (Feb. 12, 2019, 3:04 AM), https://www.bloomberg.com/news/articles/2019-02-11/china-s-space-debris-cleanup-may-be-cover-story-pentagon-says.
[16] Telephone interview with Charity Weeden, President and Co-Founder of Liquinox Consulting, LLC (Mar. 13, 2019); *see also* Jillian Scudder, *Could We Use Magnets To Clear Up Our Space Junk?*, FORBES (Dec. 28, 2016, 8:46 PM), https://www.forbes.com/sites/jillianscudder/2016/12/28/astroquizzical-space-junk-magnets/#2e518aedd736.
[17] Tereza Pultarova, *Watch a Satellite Fire a Harpoon in Space in Wild Debris-Catching Test (Video)*, (Feb. 18, 2019), https://www.space.com/space-junk-harpoon-removedebris-satellite-video.html.
[18] Capaccio, *supra* note 15.

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enable maneuverable satellites to move out of the way, self-containment to remove the satellite from space when inoperable, and regulations of materials used in designing satellites to ensure any of their debris can be extracted easily. As the future of space traffic management depends upon space debris, regulating the design and operations of satellites to ensure debris clean-up is possible, in addition to incentivizing companies to launch satellites and develop clean-up technologies will be essential to ensuring safety, security, and innovation in outer space.

III. Recommendations for Addressing Orbital Debris Issues

1. The FCC should work with other federal agencies to develop an inter-agency task force to collectively provide perspectives necessary to establishing uniform national standards and prospective plans for the future of orbital debris.

We first address the Commission's request for comment relating to its own authority to promulgate the regulations contained in the Proposed Rule. The Commission asks, "Do the provisions discussed, or other statutory provisions, provide the Commission with requisite legal authority to adopt the rules we propose today?"[19]

On consideration of the cited statutory provisions and relevant caselaw, it appears that the FCC does have the authority to promulgate provisions related to management of orbital debris, but the exact extent of those powers is unclear. 47 U.S.C. § 303 mandates that the Commission "encourage the larger and more effective use of radio in the public interest"; 47 U.S.C. § 307 allows the Commission to grant a radio broadcasting license application "if public convenience, interest, or necessity will be served thereby." The courts have consistently held that Congress has provided the FCC with "'expansive powers' and a comprehensive mandate to 'encourage the

[19] Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742 (proposed Feb. 19, 2019).

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larger and more effective use of radio in the public interest.'"[20] Imposing regulations relating to the control and mitigation of orbital debris appears to fit within this grant of statutory authority. Requiring licensees to control the space debris it produces with its satellites may help ensure the safety of other broadcasting satellites already in orbit, as well as preserve reasonable access to space for future licensees. Insofar as the relevant statutes are ambiguous as to the exact extent or scope of the FCC's powers, the agency would be afforded *Chevron* deference to define the limits of its own authority.[21] Under *Chevron*, if the statute in question is ambiguous, the court will accept a federal agency's interpretation of the statute as long as the agency interpretation is reasonable.[22]

The FCC, however, should also consider possible limitations on its authority to broadly regulate orbital debris. The Supreme Court has recognized that the FCC's "public interest, convenience, or necessity" standard, while broad, is not so indefinite "as to confer an unlimited power."[23] The Supreme Court also observed that the standard "is to be interpreted by its context, by the nature of radio transmission and reception, by the scope, character, and quality of services." Although the Commission might be afforded broad deference under *Chevron* in determining what it may regulate for the "public interest," there may be subject matter that is so far afield of its statutory grant that the FCC cannot regulate it. Arguably, regulation of orbital debris is one of those topics, given that the original statute did not contemplate the Commission's regulation of spacecraft, let alone regulation of orbital debris, and that regulating space debris seems only tangentially connected to the FCC's main purpose of facilitating and encouraging

[20] Cellco Partnership v. FCC, 700 F. 3d 534 (2012).
[21] City of Arlington, Tex. v. FCC, 133 S. Ct. 1863 (2013).
[22] Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 468 U.S. 837 (1984).
[23] National Broadcasting Co., Inc. v. United States, 319 U.S. 190 (1943).

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radio communications. Furthermore, the FCC would also need to provide substantial evidence that its proposed orbital debris regulations serve the public convenience, interest, or necessity, or "encourage the larger and more effective use of radio in the public interest."[24] It may be that the risks of orbital debris on radio communications are so speculative or remote that imposing burdensome regulations in that area would not align with the public interest or any other statutorily-mandated outcome.

Assuming that the FCC does have authority to impose orbital debris regulations, it should decline to do so alone. The Commission has specifically requested comment on the authority of other agencies and the role that the FCC should properly play in the context of other relevant stakeholders. In terms of expertise, NASA has taken a leading role in mitigation of orbital debris, and NASA considers the problem one of "high priority."[25] In 1995, NASA was the first space agency to issue comprehensive orbital debris mitigation guidelines; in 1997, NASA and the DoD led a working group that created the Orbital Debris Mitigation Standard Practices based on NASA orbital debris standards.[26] These standards were approved by all federal agencies in 2007.[27] Since then, NASA has imposed a detailed set of technical requirements on all programs and projects responsible for NASA or NASA-sponsored objects, designed to control and limit orbital debris generation.[28]

In addition, Congress' 2010 authorization bill for NASA included a set of findings related to orbital debris regulations that strongly suggest that the FCC should be but one player in a

[24] United States v. Midwest Video Corp., 406 U.S. 649 (1972).
[25] *Orbital Debris Mitigation*, NASA, https://www.orbitaldebris.jsc.nasa.gov/mitigation/ (last visited April 4, 2019).
[26] *Id.*
[27] *Id.*
[28] *Id.*

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coordinated effort to mitigate orbital debris.[29] Congress found that "[a] national and international effort is needed to develop a **coordinated approach** towards the prevention, negation, and removal of orbital debris."[30] Congress stressed the relevance of the Inter-Agency Space Debris Coordination Committee (IADC) (a working group composed of NASA and 12 other national space agencies from around the world) in developing a response to the orbital debris issue, and stated that "NASA's participation on the Committee should be robust, and NASA should urge other space-relevant Federal agencies (including the Departments of State, Defense, and Commerce) to work to ensure that their counterpart agencies in foreign governments are aware of these national commitments and the importance in which the United States holds them."[31] Congress envisioned an approach to orbital debris in which NASA would play a leading (or at least significant) role, and one in which multiple agencies would be involved in coordinating a response. FCC certainly has an important stake in controlling the orbital debris problem, but Congress does not contemplate a response that does not involve the significant participation of other agencies.

The Commission should also consider the expertise, experience, and relevance of other federal agencies. The National Oceanic and Atmospheric Administration (NOAA), a branch of the U.S. Department of Commerce, is responsible for licensing private spacefaring remote sensing systems.[32] The National and Commercial Space Programs Act (NCSPA) gives NOAA the authority to regulate the disposition of satellites whose licenses have expired, including

[29] 42 U.S.C. § 18441.
[30] 42 U.S.C. § 18441(a)(1) (emphasis added).
[31] 42 U.S.C. § 18441(a)(2).
[32] *About the Licensing of Private Remote Sensing Space Systems*, NOAA, https://www.nesdis.noaa.gov/CRSRA/licenseHome.html (last visited April 4, 2019).

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assessment and control of orbital debris that may result from the disposal.[33] For each license application, NOAA will "assess whether the plan, including satellite design and components, provide an acceptable post-mission disposal method to mitigate orbital debris and minimize any potential adverse effects. Applicants are specifically required to submit a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the spacecraft."[34] Not only does the NOAA have expertise and experience relevant to orbital debris assessments, NOAA's authority in this area may overlap with the FCC's, to the extent that the satellite operator must seek licenses from both NOAA and the FCC. These overlapping grounds for authority may lead to "duplicative activities" between the two agencies or imposition of inconsistent standards onto applicants, further strengthening the need for a coordinated, inter-agency approach to debris mitigation.

Finally, recent developments suggest that the Department of Commerce is taking a more active role in regulating space.[35] On March 26, 2019, Commerce Secretary Wilbur Ross delivered a report to President Trump titled "Driving Space Commerce Through Effective Spectrum Policy."[36] The report was prepared with the broad goal of developing policy recommendations consistent with "improving the global competitiveness of the United States space sector through radio frequency spectrum policies, regulation, and United States activities at

[33] *Id. See also* 51 U.S.C. § 60101 et seq.
[34] *About the Licensing of Private Remote Sensing Space Systems*, NOAA, https://www.nesdis.noaa.gov/CRSRA/licenseHome.html (last visited April 4, 2019).
[35] The Commission specifically requested comment on "the impact of any potential legislation or other developments related to the Commission's role, that may arise during the pendency of this proceeding."
[36] *Commerce Secretary Issues Space Commerce Spectrum Report*, Office of Space Commerce (March 26, 2019), https://www.space.commerce.gov/commerce-secretary-issues-space-commerce-spectrum-report/

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the International Telecommunication Union and other multilateral forums."[37] The Department of Commerce envisions itself as a key player in developing a licensing framework for commercial satellites, specifically recommending that "NTIA [National Telecommunications and Information Administration, a branch of the Department of Commerce] and the FCC together should streamline and improve inter-agency processes that facilitate deployment of nascent small satellites and alleviate burdens on the U.S. satellite and space industry."[38] Overall, the report seems to endorse an inter-agency response to space sector regulation, with a particular interest in promoting the United States' global competitiveness in this field. It also suggests that the Department of Commerce is interested in an expanded role regulating space; the FCC should consider this report in context and determine how the Commerce Department's goal of "eliminat[ing] regulatory burdens on commercial space activity"[39] can be harmonized with the FCC's objective of mitigating orbital debris risk.

Overall, it is clear that the FCC can contribute significantly to the issue of orbital debris, especially through its jurisdiction over telecommunications and the essential nature of satellites to that industry. In fact, at least fifty percent of satellites are related to communications.[40] As telecommunications satellites impact the lives of every American, through military, television, and telephone access, the FCC's role is essential to ensuring satellites are safe and secure in space. The FCC, though, should work together with other various agencies to gain other

[37] Driving Space Commerce Through Effective Spectrum Policy: Recommendations for Improving the Global Competitiveness of the United States Space Sector through Radio Frequency Spectrum Policies, Regulation, and United States Activities at the International Telecommunication Union and Other Multilateral Forums, Department of Commerce (March 26, 2019), https://www.commerce.gov/sites/default/files/2019-03/DrivingSpaceCommerce.pdf.
[38] *Id.* at 20.
[39] *Id.* at 1.
[40] 2017 State of the Satellite Industry Report, SATELLITE INDUSTRY ASSOCIATION (June 2017), https://www.sia.org/wp-content/uploads/2017/07/SIA-SSIR-2017.pdf.

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perspectives on the severity of space debris and the possible solutions to address it. Gathering input from the National Aeronautics and Space Administration (NASA), the Department of Defense (DoD), the Department of Commerce, the National Geospatial-Intelligence Agency, the National Reconnaissance Office, the White House Office of Science and Technology Policy, and the Small Business Administration, in addition to industry leaders in satellites and space debris resistance and clean-up, will enable the FCC to better utilize its expertise in telecommunications satellite applications to protect the industry.

2. The FCC should utilize the information gained through an inter-agency task force to incorporate the concerns of space actors internationally.

When space law first emerged in the 20th century, only two nations dominated the new frontier, the United States and Russia.[41] By 1994 however, the United Nations (UN) had set the subject of orbital debris on the agenda of its Scientific and Technical Subcommittee (STSC) within the United Nations' Committee on the Peaceful Uses of Outer Space (COPUOS). It was not until 2002, however, that the Inter-Agency Space Debris Coordination (IADC) Committee, an international forum of 13 national and multinational space agencies which had been convening experts to determine mitigation strategies for the orbital debris problem, submitted a list of guidelines to the UN for review. The IADC's guidelines were reviewed and discussed by the STSC in 2003 and 2004 and only by February 2007 had member states of this subcommittee adopted a similar set of space debris mitigation guidelines, followed by adoption of the full COPUOS in June of 2007 and by the full General Assembly in late 2007.

[41] Nina Tannenwald, *Law Versus Power on the High Frontier: The Case for a Rule-Based Regime for Outer Space*, 29 YALE J. INT'L L. 363, 371 (2004).

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Today, over thirty countries have significant space industries, and eight nations have launch capabilities.[42] The interest in space is growing, too, as many smaller nations are interested in the economic benefits space activity can provide, such as communications access.[43] While UN COPUOS has several treaties that address outer space, none of them directly address the very important problem of space debris. Additionally, despite space debris being known to the UN as a threat to space exploration and access, none of the treaties have sought to set binding principles on member nations. Spacefaring nations themselves are unlikely to be the leaders in this realm because they are self-interested in exploring space as they please.

Thus, given the growing interest and involvement in space activity, current space law faces two scenarios for the future: "muddling through" or establishing a more elaborate regime.[44] Under the first scenario, space law continues to muddle through, "continu[ing] its current practice of operating under diverse interpretations of nominally shared but vaguely specified principles, seeking incremental modifications to the existing regime where it can."[45] This practice of creating rules as needed, without focus on a comprehensive regime, will not fully address the issue of space debris, nor will it provide for a uniform binding scheme to fix the problem in time.[46] The second scenario involves the UN implementing a developed regime to address space debris.[47] This approach would require the UN as a whole and UN COPUOS specifically to negotiate rules desirable to all nations, spacefaring or not.[48]

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[42] *Id.*
[43] *Id.*
[44] *Id.*
[45] *Id.*
[46] *Id.*
[47] *Id.*
[48] *Id.*

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3. The FCC should work with other agencies to institute a set of standards for future launched objects, requiring them to meet certain criteria.

In working with other agencies, industries, and international partners, the FCC should begin researching new protocols that will both recognize current risks with orbital debris and establish consensus on the criteria for compliance that will require implementation by satellite operators. These criteria should require satellite operators to ensure that their launched objects meet the following design specifications:

1) Maneuverability to enable satellites to avoid collisions with debris;

2) Inclusion of a self-contained mechanism built into the satellite's design to ensure the object can dispose of itself or mitigate its own debris; and

3) Implementation of tracking capabilities to aid with space traffic management.

Meeting these requirements will ultimately allow for a more safe and secure outer space and will encourage more companies and individuals to commercialize low-Earth-orbit by offering them a lower-risk-environment.

Maneuverability of satellites involves both the ability for a satellite to move and to recognize when to move, for example, in the case of oncoming debris that could destroy its operations. It would also enable operators to remove the object from orbit by slowing it down and letting it fall back into the atmosphere and burn up during its re-entry.[49] Likewise, satellites should be composed of materials to enable efficient, effective, and safe clean-up. For example ferromagnetic materials used in space satellites could enable satellites designed with magnets to

[49] *See Does Space Junk Fall from the Sky?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Jan. 19, 2018), https://www.nesdis.noaa.gov/content/does-space-junk-fall-sky.

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easily capture them once they are no longer in use.[50] Tracking devices, such as RFID tags, are also possible designs to enable operators to know where satellites are located in order to avoid collisions with their own satellites.[51] Innovators of such technologies, however, should attempt to make them inexpensive in order to not hinder any operations in space, especially those conducted by student and academic researchers utilizing small satellites or cube-sats.

To ensure that satellite operators have verified that their satellites meet these specifications, the FCC should establish an enforcement system to require these parameters are in place prior to launch. This system should involve a multi-step process that begins well before launch in order to ensure protocols are being followed. Such structured protocols would also enable operators to be notified of the specifications well in advance so that they can make adjustments to their satellites if needed. Requiring the signature of operators at this point would also aid in reducing the confusion surrounding liability for damage caused by orbital debris. Implementation of these requirements would also not create large burdens upon already existing FCC licensing requirements for satellites prior to launch.[52]

Though some may argue that adding additional protocols may discourage operators from launching, these specifications would likely incentivize more individuals to begin commercial space operations than are currently participating in outer space due to the high risk of damage and loss associated with the current uncertain landscape of orbital debris. With these safeguards in place to both protect one's own satellite and other objects in space, traffic management can be

[50] Telephone interview with Charity Weeden, President and Co-Founder of Liquinox Consulting, LLC (Mar. 13, 2019); *see also* Jillian Scudder, *Could We Use Magnets To Clear Up Our Space Junk?*, FORBES (Dec. 28, 2016, 8:46 PM), https://www.forbes.com/sites/jillianscudder/2016/12/28/astroquizzical-space-junk-magnets/#2e518aedd736.
[51] Telephone interview with Charity Weeden, President and Co-Founder of Liquinox Consulting, LLC (Mar. 13, 2019);
[52] *See* Review of Licensing and Operating Rules for Satellite Services, FEDERAL COMMUNICATIONS COMMISSION, https://www.fcc.gov/document/review-licensing-and-operating-rules-satellite-services-0 (last visited Apr. 5, 2019).

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achieved and satellite operators will have greater certainty in the operations they pursue in space, leading to increased commercialization beyond Earth. Additionally, these specifications will not only encourage greater operations of satellites, but will also incentivize the creation of companies to contribute to the technology of ensuring satellites can have adequate maneuverability, tracking, and clean-up.

4. The FCC could develop incentives to counterbalance any adverse effects of introducing new regulation of launched space objects.

As a suggestion of a possible means of incentivizing current or would-be orbiting stakeholders, we present the priority review voucher model used in the medical treatment domain that has incentivized the development of treatments for rare/neglected diseases and portends to have actually created more value to the field than what it would have cost for the government to invest in the development of such treatments on its own.

In 2007, under the advice from a proposal written by health economists the previous year,[53] the US Congress created the priority review voucher program. As stipulated by the law of this program, the Food and Drug Administration (FDA) could distribute priority review vouchers (PRVs) to drug manufacturers to apply to any new drug treatment of their choosing following the manufacturer's discovery and submission of a treatment for a neglected or rare tropical disease. Given priority review, the lengthy and expensive process of reviewing a drug by the FDA would be nearly halved. Also, in each case that a PRV is awarded, both the treatment for the rare/neglected tropical disease and the treatment of the manufacturers choosing would quickly be

[53] David Ridley, Henry Grabowski & Jeffery Moe, *Developing Drugs For Developing Countries*, 25 HEALTH AFFAIRS (2006), https://www.healthaffairs.org/doi/full/10.1377/hlthaff.25.2.313 (last visited Apr 5, 2019).

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set up for approval and distribution, providing a health benefit to those receiving treatment for their rare/neglected tropical disease, but also provides financial value for the manufacturer's as the priority review ensures they can bring another more profitable treatment to the market sooner and for longer with less competition. Specifically, as blockbusters often net billions in sales for their manufacturers each year, even just the benefit of an earlier review of just a few months can be worth hundreds of millions of dollars to the manufacturer.[54]

As an alternative incentive for manufacturers, Congress' program also allows the sale of PRVs. As such, manufacturers without interest or ability in developing more marketable treatments could still be incentivized to develop treatments for rare/neglected tropical diseases by the prospect a multi-million dollar sale of an awarded PRV. For instance, in 2014, the first voucher was sold for $67.5 million[55] and just a year later another was sold for over three times that amount.[56]

Given the need and burdens of an effective mitigation strategy for the problem of orbital space debris, we suggest a similar model of PRV be considered for current or would-be orbiting stakeholders. In this case, the governing and responsible body for mitigating the problem of orbital space debris could offer incentives such as priority space launch approval vouchers, weight/frequency/location clearances, and the like for stakeholders who provide services such as clearing a set tonnage of debris, developing key technologies to address space debris challenges,

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[54] *Id.*; David B. Ridley & Stephane A. Régnier, *The Commercial Market For Priority Review Vouchers*, 35 HEALTH AFFAIRS 776–783 (2016).

[55] Ron Winslow & Joseph Walker, *Drug Firms Buy $67.5 Million Voucher to Speed FDA Review*, WALL STREET JOURNAL (2014), https://www.wsj.com/articles/sanofi-regenerons-alirocumab-shows-promise-in-phase-iii-trials-1406738434 (last visited Apr. 5, 2019).

[56] Chelsey Dulaney, *Retrophin Sells FDA Voucher to Sanofi for $245 Million*, WALL STREET JOURNAL(2015), https://www.wsj.com/articles/retrophin-sells-fda-voucher-to-sanofi-for-245-million-1432732325 (last visited Apr 5, 2019).

or assisting in the launch of smaller entities facing disproportional disadvantages from set orbital space debris mitigation policies.

Further, beyond the two immediate benefits exemplified by the PRV model, another benefit exhibited to manufacturers investing in the development of rare/neglected tropical diseases has been the increased participation of investors hoping to support the development of treatments destined to gain the financial incentives of PRVs described above. In one such case, the Global Health Investment Fund allocated $10 million to Medicines Development[57] of Australia, a non-profit drug development to complete its registration of moxidectin, a treatment for river blindness. As a treatment for a rare and neglected tropical disease, moxidectin, if approved, will not only benefit those affected by river blindness, but the Global Health Investment Fund will also gain some of the monies earned with the PRV to then reinvest elsewhere for the alleviation of other global health concerns. In the case of orbital space debris, similar investors or funding agencies could likewise stand to benefit by investing in those seeking to acquire a PRV for space.

Furthermore, as a continuation of our assessment of the problem of orbital debris being [58]constantly evolving and a global issue, the PRV program also serves as a great model for an incentive model that has evolved to alleviate other rare and neglected diseases, such as rare pediatric diseases in 2012 with the passage of the FDA Safety and Innovation Act, and has also been considered for adoption abroad in the European Union.[59] Similarly to the extension of the

[57] *Press Release: GHIF Finances Registration of Moxidectin for Onchocerciasis*, GLOBAL HEALTH INVESTMENT FUND (2015), http://www.ghif.com/uncategorized/press-release-moxidectin/ (last visited Apr 5, 2019).
[58] The Food and Drug Administration Safety and Innovation Act (P.L. 112-144).
[59] David Ridley & Alfonso Sanchez, I*ntroduction of European priority review vouchers to encourage development of new medicines for neglected diseases*, THE LANCET (2010), http://www.sciencedirect.com/science/article/pii/S0140673610606691 (last visited Apr 5, 2019).

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PRV program to include rare pediatric diseases, the same idea for the PRV program was extended to the United States Patent and Trademark Office with its "Patents for Humanity"[60] pilot program encouraging businesses to apply patented technology to address humanitarian challenges. If granted, applicants to the program would receive a voucher that would grant the recipient the ability to move/accelerate certain patent proceedings to the front of the office's queue.

Researching an incentive program already in use by other agencies, such as the PRV program, would also grant the benefit of learning from the programs limitations and lessons learned. For instance, one concern of the PRV program has been the burden it may place on the FDA. While the PRV process ostensibly creates a tremendous amount of value from simply offering the ability to rearrange the order of FDA's reviews, doing so may consume the agency's resources. To mitigate this concern, the PRV voucher requires a fee and a 90-day advance notice of PRV applicants that is projected to be sufficient to cover such costs.[61] Another similar concern yet to be fully addressed by the PRV program is that ensuring treatment safety as the promise of a priority review may cause evaluators to cut corners during the review process. In the case of mitigating orbital space debris, sufficient policies and resources would have to be made available to prevent any premature or insufficient space launch approvals.

Another emerging issue that would have to be addressed is the determination of the value of such a prize in a model to incentivize the entities to mitigate the challenge of orbital space debris. Without universal adherence to space debris regulations, such a program could be

[60] *Patents for Humanity*, U.S. PATENT & TRADEMARK OFFICE, http://www.uspto.gov/patents/init_events/patents_for_humanity.jsp (last visited Apr 5, 2019).
[61] David Ridley, T*he Regulatory Burden Of The Priority Review Voucher Program*, HEALTH AFFAIRS (2015), https://www.healthaffairs.org/do/10.1377/hblog20151028.051452/full/ (last visited Apr 5, 2019).

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undercut by another country with more lenient space debris policies or none whatsoever. In the case of PRV for medical treatments, a major assumption inherent to the model is the value of the treatment being available to the US market which is gatekept by the FDA. In the case of mitigating orbital space debris, a PRV program would only work if the benefits of launching in participating countries outweighs launching the countries that are not participating members.

IV. Conclusion

Issues surrounding orbital debris will not disappear on their own. In this comment we provide a comprehensive response to the Federal Communications Commission's (FCC) request for comments regarding its efforts to mitigate the problem of orbital space debris.[62] In doing so, we have provided analyses of several of the topics covered in the Commission's request and recommend that the FCC work with national and international partners to address the issue of orbital debris from multiple perspectives as this issue affects a multitude of sectors. We have also compared several models of incentivizing assistance in mitigating space debris from space-faring stakeholders while also presenting the FDA's priority review voucher program as another potential model of incentivization for the Commission to consider. We respectfully submit this comment for the Commission's consideration and will make ourselves available should the Commission seek further clarification or guidance.

[62] Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742 (proposed Feb. 19, 2019).

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